Chemical Control of Two Leaf Spot Diseases of Cluster Yam (*Dioscorea dumetorum*) Caused by *Cercospora contraria* and *Didymosphaeria donacina*

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ABSTRACT

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Five fungicides (captan, basic copper chloride, captafol, mancozeb, and Phaltan) were evaluated for inhibition of germination of the conidia of *Cercospora contraria* and *Didymosphaeria donacina*, which cause two leaf spot diseases of *Dioscorea dumetorum*. The fungicides were also evaluated after artificial infection in the greenhouse and natural infection in the field during two growing seasons. Four of the fungicides (captan, captafol, mancozeb, and Phaltan) were consistently effective in inhibiting germination of the conidia in the laboratory and inhibiting the diseases in the greenhouse and in the field. Mancozeb, however, has been recommended for field use because of its effectiveness, low phytotoxicity, low cost, and the apparent luxuriant growth it induced in treated plants.

Two important leaf spot diseases have been reported on cluster yam (*Dioscorea dumetorum* Pax). Bailey (1), Coursey (3), and Chupp (2) listed and described the Cercospora leaf spot caused by *Cercospora contraria* H. & P. Syd. Emua and Fajola (6) recently described a new leaf spot caused by *Didymosphaeria donacina* (Niessl.) Sacc. on the crop.

Although some investigations have been carried out on the control of anthracnose of some cultivated yams (9,12) and Cercospora leaf spot disease of other crops (7,10), investigations on the control of the two leaf spot diseases of *D. dumetorum* have not been reported. A report on the chemical control of these two diseases is presented in this paper.

MATERIALS AND METHODS

Five fungicides were evaluated for inhibition of the germination of the conidia of *C. contraria* and *D. donacina*. The five fungicides included captan (50% WP), basic copper chloride, mancozeb, captafol (50% WP), and Phaltan.

Evaluation of the fungicides was carried out according to the method employed by Dhanvantari (4) and Fajola and Alasoadura (7). Solutions or suspensions of the fungicides were prepared to give the following concentrations of their active ingredients: 0, 10, 25, 50, 100, 250, 500, and 1,000 ppm. One milliliter of each concentration of fungicide or sterile distilled water (0 ppm, control) was sprayed with a syringe on the solidified surface of potato-nutrient agar (PNA) in petri dishes and allowed to stand for 4 hr. One drop (0.1 ml) of conidial suspension (10^5 conidia per milliliter) was placed at each of four points midway between the center and the rim of each plate, which gave four replicates in each plate. In each series of experiments, five plates were set up for each concentration. The plates were incubated at 26 C for 6 hr before fixing in formalin acetic alcohol (FAA) prepared according to the method of Sharma and Sharma (11). The conidia germinating and those not germinating from each of the four inoculated areas in each plate were carefully counted under the microscope at low power (×100) and the percent inhibition of germination was calculated. The LD_{50} value of each fungicide (in ppm) was obtained from a graph plot of percent inhibition of germination against fungicide concentration.

In the greenhouse trials, the method of Fawcet et al (8) was used. The 10 lowermost leaves of spotfree six-mo-old yams were sprayed with one of the following concentrations of each of the four fungicides (captan, captafol, mancozeb, and Phaltan): 100, 250, 500, and 1,000 ppm and sterile water (control). The leaves were sprayed to runoff. After drying, the leaves of five plants sprayed with one concentration of each fungicide or sterile water were sprayed with a conidial suspension (10^5 conidia per milliliter) of *C. contraria*, and the remaining five plants were sprayed with the same concentration of conidia of *D. donacina*. The environmental conditions in the greenhouse during the experiment were temperatures of 24–32 C and relative humidities of 75–86%. The disease rating for each treatment was estimated 20 days after inoculation and expressed as percent protection, using the formula:

$$\% \text{ Protection} = ([\text{disease rating in control} - \text{disease rating in each fungicide treatment}]/\text{disease rating in control}) \times 100/1$$

similar to that used by Singh and Prasad (12). In these experiments, however, the disease rating for each treatment was taken as a product of the incidence (percentage of leaves infected) and severity (average number of spots per leaf).

Table 1. Mean percent inhibition of germination of conidia of *Cercospora contraria* and *Didymosphaeria donacina* on potato-nutrient agar (PNA) by five fungicides[a]

Concentration (ppm)	Captan	Basic copper chloride	Captafol	Mancozeb	Phaltan
		Cercospora contraria			
10	57.3 ± 0.2	0.0	56.2 ± 0.3	67.4 ± 0.3	58.4 ± 0.2
25	81.6 ± 0.4	0.0	83.2 ± 0.5	89.7 ± 0.3	77.1 ± 0.4
50	85.9 ± 0.5	12.5 ± 0.2	86.4 ± 0.2	92.5 ± 0.5	92.3 ± 0.3
100	93.4 ± 0.2	15.6 ± 0.3	92.8 ± 0.3	100.0	100.0
250	98.6 ± 0.1	25.1 ± 0.5	97.5 ± 0.2	100.0	100.0
500	100.0	34.3 ± 1.1	100.0	100.0	100.0
1,000	100.0	62.6 ± 0.6	100.0	100.0	100.0
		Didymosphaeria donacina			
10	20.7 ± 0.2	0.0	27.2 ± 0.1	28.0 ± 0.3	34.6 ± 0.2
25	39.3 ± 0.4	2.8 ± 1.2	33.1 ± 0.3	46.6 ± 0.2	48.5 ± 0.1
50	56.9 ± 0.3	15.2 ± 1.4	52.6 ± 0.2	76.2 ± 0.1	75.9 ± 0.3
100	75.1 ± 0.3	18.6 ± 1.2	69.7 ± 0.4	100.0	100.0
250	100.0	28.2 ± 1.3	100.0	100.0	100.0
500	100.0	36.4 ± 0.2	100.0	100.0	100.0
1,000	100.0	58.1 ± 0.4	100.0	100.0	100.0

[a] Data are means of 32 determinations from two separate experiments.

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The four fungicides were also tried against natural infection by *D. donacina* and *C. contraria* in the field on 6-mo-old stands of *D. dumetorum*. The plants were raised on a 0.25-ha plot in the botanical nursery of the University of Ibadan during the two growing seasons of 1978 and 1979.

The spraying of the plants in the plot was started 6 mo after planting (when the disease first appeared) and was continued at 3-wk intervals for 4½ mo, after which all of the tubers would have been set. Three concentrations of each fungicide (250, 500, and 1,000 ppm) and sterile water (control) were sprayed separately on different sets of plants in the plot. In all trials, hand-sprayers were used to apply a measured volume (100 ml) of fungicide to each plant. During this spraying period (4½ mo) there was about 1,294 mm of rainfall and the temperature range was 23–32 C. The disease rating in the plots sprayed with the different fungicides was estimated and expressed in percent protection. The tubers of the stands of yam treated with the different concentrations of each fungicide and those of the control were carefully harvested, washed free of sand particles, and their fresh weights recorded. The average weight of tubers in each treatment was estimated as percent increase in yield as follows:

% Increase in yield due to treatment = ([yield in treatment − yield in control)]/yield in control × 100/1.

RESULTS

The activity of the fungicides against the germination of the conidia of *C. contraria* showed the four organic fungicides, mancozeb, Phaltan, captan, and captafol, to be effective (Table 1). Their LD_{50} values (in ppm) were as follows: captan, 8.6; basic copper chloride, 770; captafol, 9.0; mancozeb, 7.5; and Phaltan, 8.5. Mancozeb, Phaltan, captan, and captafol were found consistently effective against the germination of conidia of *D. donacina*, whereas basic copper chloride was not (Table 1). The LD_{50} values of the fungicides (in ppm) were: captan, 34.1; basic copper chloride, 812; captafol, 46.5; mancozeb, 29.1; and Phaltan, 29.5.

Observations of the greenhouse trials against artificial infection by *C. contraria* and *D. donacina* (Table 2) showed that the four tested fungicides were effective against the two pathogens. Mancozeb, however, consistently gave better protection at each of the concentrations. Phaltan was next, followed by captafol and captan, in order of effectiveness. When the data obtained in three separate experiments were subjected to statistical analysis (*t* test), percent protection ratings recorded for the different fungicides at the same concentration were not significantly different at $P = 0.05$.

Captan and captafol were only effective against the two leaf spot disease pathogens of *D. dumetorum* in the field (Table 3) at very high concentrations (500 ppm and higher). Mancozeb and Phaltan, on the other hand, were found very effective even at low concentrations (250 ppm). In addition, mancozeb consistently gave better protection at each of the concentrations and the growth of stands treated with the fungicide was luxuriant. None of the fungicides proved phytotoxic at any of the concentrations tested. Yield was increased in yam stands treated with two of the fungicides; however, stands treated with mancozeb consistently gave a higher yield (52.4% increase at 500 ppm) than those treated with the same concentration of Phaltan (47.6% increase). The yield data from yams treated with 1,000 ppm of each of the two fungicides were not significantly different ($P = 0.05$) from data obtained with 500 ppm.

DISCUSSION

The four organic fungicides (captan, captafol, mancozeb, and Phaltan) were found more effective than the inorganic fungicide (basic copper chloride) in all experiments. These results agree with the findings of Fournet et al (9) and Singh and Prasad (12) that organic fungicides are more effective in controlling anthracnose of *Dioscorea alata* L.

Although the four organic fungicides were effective against the pathogens and their leaf spot diseases, mancozeb consistently proved to be the better choice. The results of the various investigations revealed its high fungicidal activity, low phytotoxicity, low cost, and the luxuriant growth it induced in treated plants. The fungicide could therefore be recommended for the control of the two leaf spot diseases of *D. dumetorum* caused by *C. contraria* and *D. donacina* by spraying 6-mo-old plants with 500 ppm of fungicide at 3-wk intervals for about 4 mo. Similarly, the fungicide was found effective in controlling the frog-eye disease of tobacco (*Nicotiana tabacum* L.) caused by *Cercospora nicotianae* Ell. & Ev. (7) and the freckle disease of the oilpalm (*Elaeis guineensis* Jacq.) caused by *Cercospora elaeidis* Steyaert (10). It is noteworthy that this fungicide has been found effective against two unrelated pathogens and their diseases on the same crop in these studies. Drozdovskaya (5) similarly found that two leaf diseases of *Dioscorea nipponica* Makino caused by *Septoria* and *Puccinia* species could be effectively controlled by applying 0.2% carboxin, an organic fungicide.

Table 2. Percent protection obtained by using different concentrations of four fungicides against artificial infection of *Dioscorea dumetorum* in the greenhouse by *Cercospora contraria* and *Didymosphaeria donacina*

Concentration (ppm)	Captan	Captafol	Mancozeb	Phaltan
	Cercospora contraria			
0	0	0	0	0
100	59.2[a]	64.9	69.4	66.8
250	73.9	75.7	87.2	84.1
500	93.2	94.3	98.1	97.5
1,000	99.6	99.7	100.0	99.9
	Didymosphaeria donacina			
0	0	0	0	0
100	48.0	52.4	60.0	57.8
250	72.5	74.4	90.7	89.4
500	96.1	97.3	99.4	99.1
1,000	99.7	99.7	100.0	99.9

[a] Difference between concentrations and between fungicides were not significant ($P = 0.05$).

Table 3. Percent protection obtained by using different concentrations of four fungicides against leaf spot diseases of *Dioscorea dumetorum* in the field caused by *Cercospora contraria* and *Didymosphaeria donacina*

Fungicides	Percent protection for different fungicides				
	0 ppm (control)	100 ppm	250 ppm	500 ppm	1,000 ppm
Captan	0	44.7[a]	68.2	84.7	97.9
Captafol	0	51.5	74.5	87.9	98.4
Mancozeb	0	58.8	86.0	95.9	99.7
Phaltan	0	55.9	82.6	92.9	99.5

[a] Difference between fungicides and between concentrations were not significant ($P = 0.05$).

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